Cognitive and Affective Predictors of Emotional Reactivity in University Students

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Abstract

Background: Difficulties in emotional reactivity have repeatedly been associated with the development of psychopathology and generalised poorer outcomes. While much of this research has been conducted using self-report measures, laboratory based mood inductions may provide novel insights into factors associated with emotional reactivity. Research thus far has been predominantly focussed on factors predicting reactivity to anger or stress and little is known about what might predict reactivity to sadness. Aims: to identify cognitive and affective factors associated with emotional reactivity in a laboratory based sad mood induction experiment. Method: Participants (*N* =140, Mean age = 19.37, 71% Female) completed self-report questionnaires measuring cognitive, affective and behavioural tendencies. Following this, participants experienced both a negative (sad) and neutral mood induction (MI) procedure. Mood conditions were counterbalanced across participants. Sadness was measured using a visual analogue rating scale. Participants rated levels of sadness at baseline and after each MI. Emotion reactivity was the reported sadness following the sad MI controlling for baseline sadness. Results: Compared to baseline, reported sadness increased after the sad mood induction. Correlation analysis showed a significant relationship between aspects of temperament, behavioural systems, irritability and sadness. A hierarchical linear regression revealed that the BIS, a measure of behavioural inhibition, was the only factor to significantly predict emotional reactivity. The addition of any other correlates did not add any significant predictive value. Post hoc analyses showed that the anxiety domain of the BIS significantly predicted emotional reactivity. The fear domain of the BIS did not add any significant predictive value. Conclusions: These findings indicate that the BIS, and in particular the Anxiety portion of the BIS, predicts emotional reactivity to a sad mood induction. Results can be used to inform future research in the field by creating a platform for work with a clinical population.

Introduction

Emotional reactivity is the system response to a person-situation transaction (Gross, 2014). Reactivity refers to the physiological, behavioural and emotional response to a stimulus or event and is measured by the level of onset, the intensity and the duration of the response (Nock et al., 2008). Over the past decade, research has identified a number of negative outcomes associated with difficulties in emotion expression (Pine et al., 2001). Additionally, research has identified a number of potential predictive factors of emotional reactivity (e.g. Bolger & Zuckerman, 1995), however little is known about predictors of reactivity to a sad stimulus.

In general, individuals displaying higher levels of emotional reactivity have been reported as showing higher rates of negative outcomes in mood, cognitive, behavioural and personality aspects (e.g. Barkley, 1997, Nock et al., 2008, Rottenberg et al., 2002). Outcomes have been reported at both a clinical and sub-clinical level with early problems with emotional reactivity being linked to clinical disorders in the long term (Pine et al., 2001, McLaughlin et al., 2010). Adolescent levels of emotional reactivity have been linked to the development of depression and anxiety in adulthood (McLaughlin et al., 2010). Additionally, high levels of emotional reactivity have been linked with higher levels of behavioural disinhibition as is seen in individuals diagnosed with Attention-Deficit/Hyperactivity Disorder (ADHD) (Barkley, 1997), substance use and self-injurious thoughts or behaviour (Nock et al., 2008).

Emotional Reactivity

It is a fact that emotional reactivity (ER) varies for each human experience (Lucas & Baird, 2004). There are differences in the intensity and duration of emotional responses across individuals (Lucas & Baird, 2004) as well as differences in recovery time and the strength of

the emotional stimulus required to produce a reaction (Becerra & Campitelli, 2013). While an individual's emotions will vary based on the circumstance, reactivity tends to be relatively stable (Diener & Larsen, 1984). That is, individuals who are happier than average when they are at a party, also tend to be happy when they are at work or at home (Diener & Larsen, 1984, Lucas & Baird, 2004). However, reactivity may vary between negatively versus positively charged stimuli (Davidson, 1998, Rottenberg et al., 2002). That is, an individual who responds strongly to an event eliciting a negative emotion such as a threat of harm that may elicit fear, does not necessarily respond with the same strength to an event eliciting a positive emotion, such as an announcement of reward that may elicit happiness (Wheeler et al., 1993). Furthermore, reactivity may differ across sub-sets of emotions based on arousal (Angie et al., 2011) that is, emotions that elicit high arousal (e.g. anger, stress) may differ from those that elicit low arousal (e.g. sadness, boredom). In general, individuals who display high levels of extraversion have been reported to experience more positive emotions while those who display high levels of neuroticism have been reported to experience more negative emotions (Thake & Zelenski, 2013). A portion of the variance in these emotional experiences is known to be accounted for by difference in emotional reactivity to certain events or stimuli (Lucas & Baird, 2004). Rottenberg (2005) has proposed a model stating that those who experience clinical levels of depression are more likely to show low levels of emotional reactivity while individuals diagnosed with ADHD show higher levels of emotional reactivity (Barkley, 1997). It is therefore pertinent to further our understanding of the factors associated with emotional reactivity. For the purpose of this study, consistent with general research, emotional reactivity is defined as the emotional response to an event, the intensity of the reaction, the speed at which the reaction peaks in intensity and the return from peak back to baseline (Davidson, 1998). Past research has identified a number of factors associated with emotional reactivity.

Emotional Dysregulation

Emotional reactivity can be moderated by a person's emotional regulation skills (Retz et al., 2012). Emotional regulation, from a theoretical standpoint, is thought of as the process of inhibiting emotional reactions to events or stimuli and reorganising these emotions to refocus attention or reconstitute cognitive conditions (Retz et al., 2012). It is thought that those individuals who display heightened emotional reactivity, may have problems with their emotional regulation (Retz et al., 2012). Poor emotional regulation is referred to as emotional dysregulation. It can manifest in behavioural problems through uncontrolled angry outbursts and aggression (Eisenberg et al., 1993) and is often present in individuals diagnosed with disorders such as: attention deficit hyperactivity disorder, autism spectrum disorders, bipolar disorder, borderline personality disorder, complex post-traumatic stress disorder, and foetal alcohol spectrum disorders (Retz et al., 2012). Emotional regulation is closely associated with executive functioning as these are cognitive processes aimed at controlling behaviours (Weigard & Huang-Pollock, 2017).

Factors Associated with Emotional Reactivity

Personality

Eysenck's (1967) theory of personality states that personality can be split into two dimensions which he called second order personality traits: Introversion/Extraversion and Neuroticism/ Stability. As per the theory, the Extraversion dimension is thought to be orthogonally related to the Neuroticism dimension. He posits that individuals high in extraversion are more social, active, optimistic and more influenced by reward, while those low in extraversion are more passive, unsociable, and easily conditioned. Eysenck's theory also holds that individuals high in neuroticism are more reactive to negative stimuli or are

more prone to negative experiences from environmental events than those low in neuroticism (more stable).

Bolger and Zuckerman (1995) posit that neuroticism is a personality trait that predicts emotional reactivity levels. They propose that neuroticism is stable throughout the life span, therefore implying that reactivity also remains stable. Others have stated that extraversion is linked to high emotional reactivity (Hamann & Canli, 2004). Individuals with high levels of neuroticism and extraversion may display higher levels of emotional reactivity to negative and positive events, respectively, when compared with individuals showing lower levels of these traits even when tested in a laboratory setting (Gomez et al., 2000).

As such, it has been proposed that temperamental differences can explain differences in emotional experiences, including reactivity (Thake & Zelenski, 2012).

Behavioural Inhibition System/Behavioural Activation System

Building on Eysenck's work, Gray's (1981) Reinforcement Sensitivity Theory posits that emotional reactivity differs between negative and positive stimuli based on responsiveness to reward and punishment. He proposed the Behavioural Inhibition System (BIS) and the Behavioural Activation System (BAS) as systems to explain these differences (e.g. Gray et al., 2016) with the BIS being related to Eysenck's theory of high neuroticism and the BAS related to high extraversion. Carver and White (1994) designed a scale to measure levels of these two systems, called the BIS/BAS scale. This scale has been used extensively in the literature to measure inhibitory and excitatory tendencies in behaviour (e.g. Poythress et al., 2008, Voigt et al., 2009).

The BIS measures the experience of anxiety (Carver & White, 1994). It is responsive to punishment and negative stimuli (Thake & Zelenski, 2012) suggesting that those who have higher levels of BIS react more strongly to negative emotional stimuli. It is generally thought

to be related to high neuroticism, low extraversion and trait anxiety (Gray, 1981). Recent studies have posited that, although it has always been conceptualized as a singular scale, the BIS scale may be representative of two separate sub-scales: fear and anxiety (Gray et al., 2016, Heym, 2008). A growing number of studies have shown that removing three of the items to create a BIS fear subscale, with the remaining four items forming a BIS anxiety subscale can improve the model fit (Gray et al., 2016, Heym, 2008).

The BAS consists of three sub-scales (Gray et al., 2016): Fun Seeking, the tendency to impulsively reach for a reward, Drive, the pursuit of a desired goal and Reward Responsiveness, positive reward responsivity. High BAS scores have been generally related to high extraversion, low neuroticism and high trait impulsivity (Carver & White, 1994).

While the BIS has been linked to high reactivity to negative stimuli, there is limited research looking specifically at how levels of BIS and BAS effect an individual's reactivity to sadness, a negative valence, low arousal emotion. Gray's theory shows that high BIS is linked to high responsiveness to punishment and it has been proposed that this would imply a similar reactivity to sad stimulus (Thake & Zelenski, 2012). This is based on the fact that experimental designs often use a punishment like stimulus to induce sadness (death of a loved one, feedback of failure) therefore it is proposed that, even in studies inducing sadness, punishment is already being assessed so the reaction to these two stimuli could be similar.

Childhood Attentional Difficulties

Attentional control has been linked to emotional reactivity in children diagnosed with ADHD (Eisenberg et al., 1993). While common symptoms of childhood inattention include an inability to focus, becoming easily distracted, being forgetful or losing things and not listening to others, some researchers include managing affective interference as a feature of attentional difficulties (Brown, 1996). Managing affective interference refers to regulating

ones emotions in the face of an emotional stimuli (Retz et al., 2012). Inattention is a key diagnostic feature of ADHD (DSM-5) which is shown to be related to emotional dysregulation (Retz et al., 2012). Many individuals who have been diagnosed with ADHD have shown high levels of emotional reactivity (Retz et al., 2012, Eisenberg et al., 1993). In fact, there has been some debate as to whether or not emotional dysregulation should be included as a diagnostic feature of ADHD (Retz et al., 2012). Whether the problem for these individuals lies in the ability to regulate their emotions or in their initial emotional reactivity is unclear. The process of emotional regulation is often an automatic, intrinsic process that will be carried out without the individuals' conscious knowledge, therefore it is categorically intertwined with the concept of emotional reactivity.

Irritability and Aggression

Irritability and a proneness to aggression and trait anger are constructs that are often hard to disentangle. What bonds them together as constructs is the overarching emotional dysregulation across all three (Deveney et al., 2019). Both proneness to aggression and irritability are defined by high levels of reactivity to an event or stimulus (Deveney et al., 2019), therefore they would be expected to predict reactivity to a sad mood induction. As sadness is a low arousal emotion however, the reactivity may not be as distinct as it would to a high arousal emotion such as anger. As trait anger is defined as a predisposition to negative affect (Deveney et al., 2019), it may also be expected to predict reactivity to a sad mood induction although it does not necessarily relate to reactivity in the same way as irritability.

Executive Functioning

Studies have linked executive functioning to emotional reactivity although the causal relationship is currently unclear (Lethbridge & Allen, 2008). Executive functions are

cognitive processes that allow individuals to control behaviours and to select behaviours that will assist in the fulfilment of chosen goals (Weigard & Huang-Pollock, 2017). It is thought that perhaps dysfunctional thinking patterns, such as those associated with depression, are related to emotional vulnerability (Lethbridge & Allen, 2008). Sad mood induction studies have shown that individuals with a higher level of dysfunctional thinking report higher levels of depressed mood after the mood induction procedure (Lethbridge & Allen, 2008). Studies have shown emotional reactivity to be linked to executive functions such as working memory, perception, attention, and decision making although the nature of these effects may vary between positive and negative emotions (Chepenik et al., 2007). Studies in which healthy individuals have participated in a sad mood induction have demonstrated a mood congruent memory bias (Chepenik et al., 2007). In word recognition tasks negatively valenced words were more likely to be recalled than neutral words (Chepenik et al., 2007), suggesting that mood has an effect on cognitive processes. Four common components of executive functioning are Self-Restraint, Self-Motivation, Self-Organisation and Emotional Regulation (BDEFS). Reactivity to negative moods, namely anger, sadness and worry/guilt, have been shown to negatively correlate with self-restraint in young boys (Weinberger & Gomes, 1995). That is, the more reactive a child was to a negative stimuli or event, the more he 'acted out' showing less restraint over his behaviour (Weinberger, & Gomes, 1995). The controlling nature of executive functions and the link in the literature of dysfunctional thinking to heightened emotional vulnerability might indicate that differences in executive functioning could explain differences in emotional reactivity.

Sadness

Sadness is an emotion with low arousal and negative valence. It is evoked from the loss of an important object or idea (Lazarus, 2001). While sadness is a normal emotional state that can

be intense but is temporary, prolonged sadness or a persistent sad mood, when accompanied with other symptoms, is a key diagnostic feature of clinical depression and anxiety (American Psychiatric Association, 2013).

Studies assessing the effect of prolonged sad mood on cognitive functioning have shown a detrimental effect on memory, attention and perception along with deficits in executive functioning (Chepenik et al., 2007). Functional neuroimaging studies have demonstrated a link between sad mood, both at a clinical level and in healthy participants, and the prefrontal and limbic brain regions (Chepenik et al., 2007). These regions are associated with cognitive functions such as working memory and inhibitory processing (Chepenik et al., 2007). In judgement and decision making tasks some studies show that sadness increases an individual's likelihood to take risks (Blanchette & Richards, 2010) while others show no effect (Angie et al., 2011).

While a number of studies concerned with negative emotion reactivity have examined predictors of negative valence/high arousal states (e.g. Hamann & Canli, 2004), the literature on factors associated with reactivity to sad stimuli is both limited and inconsistent. The research thus far has purported that an historic diagnosis of Major Depressive Disorder is linked to levels of reactivity (Rottenberg et al., 2005). While paradoxical, research has shown that individuals diagnosed with Major Depressive Disorder display less emotional reactivity to sad stimuli, despite their persistent sad mood (Rottenberg et al., 2005), suggesting a blunting effect of depression on emotional reactivity (Rottenberg et al., 2005).

Within a non-clinical sample, baseline sad mood has been reported to be associated with increased level of emotional reactivity (Scherrer & Dobson, 2009), although this has not been replicated. Recent negative life events have been shown to affect level of emotional reactivity in some studies (Blackburn et al., 1990), although not in others (Scherrer & Dobson 2009). The research is also contradictory when it comes to cognitive patterns, as while studies

have presented negative thought patterns to be associated with emotional reactivity, they have also shown negative attitudes not to be associated (Scherrer & Dobson, 2009).

Aims of the Current Study

The significance of emotional reactivity in the development of disordered psychopathology and generalised poorer outcomes alongside the relatively sparse understanding of its cognitive and affective predictors lead to the evolution of the current study. Prior research has identified a number of predictors of emotional reactivity to negative, high arousal emotions. Less is known about the factors associated with sadness. This study aims to further understand the factors associated with emotional reactivity as a function of induced sad mood by exploring the relationship between level of emotional reactivity and participant reported cognitive and affective factors.

Hypothesis

Based on a review of the current literature, it is hypothesised that measures of childhood inattention, irritability/aggression, depression/anxiety, executive functioning and personality, including the behavioural inhibition system, will be associated with level of emotional reactivity to a sad mood induction procedure.

Method

Participants

Data was collected from 156 student volunteers (70.3% Female) enrolled in an introductory psychology course at a regional university in New Zealand. Participants were 18-25 years old (Mean age= 19.42) and signed up using the university's research system,
Sona Systems. Students received extra course credit for participating. Sixteen students were excluded as per the study protocol, these cases were excluded from any further analysis.

Design

This study was a within-subjects design which aimed to investigate the factors associated with the emotional reactivity to an induced sad mood. As such, participants served as their own control. Negative and neutral mood states were induced using an adaptation of the Mood Induction Paradigm (MIP; Robinson et al., 2012). The MIP is a standardised computerised procedure where a mood (neutral/sad) was induced by listening to emotion specific classical music and reading 20 emotion specific sentences. The experiment followed an AB-BA design to control for order effects. Mood ratings were recorded using a computer presented visual analogue scale at baseline and after each mood induction.

The design of the experiment is as follows:

VAS → MIP(a) → VAS → MIP(b) → VAS

Figure 1. *Visual outline of mood induction experimental procedure [VAS = Visual Analogue Scale; MIP = Mood Induction Paradigm; (a) Neutral; (b) Negative; order was counterbalanced*

Procedure

Potential participants presented at a predetermined designated time at a university laboratory. A research assistant presented each participant with an informed consent form that outlined the study design, explained the purpose of the study, and detailed the risks and benefits involved. This information was reviewed by the researcher. After signing the informed consent, participants were assigned a random four-digit identification number to ensure confidentiality.

Participants then completed a number of self-report questionnaires assessing basic demographic information, establishing suitability for study participation and providing information on cognitive and emotional functioning. Exclusion criteria consisted of the following factors: being outside of the specified age range (18-25); having received a traumatic brain injury; having concussion in the past year or currently experiencing symptoms from a prior concussion; and current diagnosis of a perceptual disorder. Additionally, participants reporting current levels of anxiety or depression that fell above the clinical cut-off were excluded. These participants (n = 16) were allocated to the neutral only condition and received full credit for their participation. Once the questionnaires were completed the researcher explained the instructions of the study.

The participants then took part in the mood induction tasks. Negative and neutral moods were induced using an adapted form of the Mood Induction Procedure (Robinson et al., 2012). The procedure takes approximately 15 minutes and is a computerised procedure requiring minimal researcher intervention. The participant is given a set of headphones through which either emotionally charged or neutral classical music is played. The computer displays sentences for the participant to read which match the condition (either emotionally charged or neutral). Each sentence remains on the screen for twelve seconds. The emotionally

charged sentences and music are designed to evoke a sad mood, they are sourced from the 'Velten' procedure (Velten, 1968). An example of the sentences is "All the unhappiness of my past life is taking possession of me". The participants were asked to assume the suggested emotion by relating the sentences to their own lives.

Participants were set with both a negative and neutral mood induction paradigm. Negative and neutral mood inductions followed an AB-BA design to control for order effects. Participants were asked to report mood before and after each protocol using the visual analogue scale (VAS).

Prior to the participant leaving, they were monitored until their VAS score corresponded with their mood at baseline. Each participant was advised about resources they can access if they need help with their mental health.

Measures

Visual Analogue Mood Rating Scale (VAS) asks participants to rate their mood on a scale from one through to ten based on how happy, sad or bored they are at the time.

Demographics and Psychiatric History/Current Status (PHCS): This questionnaire was developed in the lab for the purpose of the current study. The demographics questionnaire assesses basic demographic information and any physical head trauma that may interfere with the study. The *PHCS* is a questionnaire measuring history diagnosis and treatment of mental health disorders and behavioural problems.

Patient Health Questionnaire-9 (PHQ-9): A standardised measure endorsed by the National Institute for Health and Clinical Excellence. The PHQ-9 is a nine-point questionnaire with a

four-point scale of agreement (0= Not at all, 3= Nearly every day). Used to screen for and measure severity of depressive disorders. (Kroenke et al., 2001)

General Anxiety Disorder-7 (GAD-7): A seven-point questionnaire with a four-point scale of agreement (0= Not at all, 3= Nearly every day). Used to screen for and measure severity of anxiety disorders. (Kroenke et al., 2007)

The Aggression Questionnaire (AQ): The AQ reports on four aspects of aggression: Physical Aggression, Verbal Aggression, Anger and Hostility. It consists of twelve statements with participants using a five-point scale to rate the accuracy of the statements when related to themselves. Statements are rated from 'Extremely uncharacteristic of me', to 'Extremely characteristic of me'. (Buss & Perry, 1992)

The Affective Reactivity Index (ARI): A scale for the dimensional measurement of irritability using examples from the past six months. Seven items are ranked on a three-point scale from 'Not true', through to 'Certainly true'. (Stringaris et al., 2012)

The Barkley Adult ADHD Rating Scale-IV (BAARS-IV quick screen): Assesses current adult ADHD symptoms and domains of impairment for the past six months. It consists of five statements which participants rate on a four point scale from 'Never or rarely', to 'Very often'. If a participant rated any of these five statements as happening 'Often' or 'Very often' then follow-up questions regarding age and setting of impairment are required. An almost identical set of questions are answered for memories of childhood symptoms between the ages of five and twelve. (Barkley, 2011a)

The Barkley Deficits in Executive Functioning Scales (BDEFS for Adults): An empirically based tool for evaluating dimensions of adult executive functioning in daily life. Made up of 20 questions that can be split into four separate subscales identifying levels of Self Restraint, Self-Motivation, Self-Organisation and Emotional Regulation. Each statement is rated on a four point scale of agreement (1=Never or rarely, 4=Very often). (Barkley, 2011b)

The Behavioural Inhibition System and Behavioural Activation System Scale (BIS/BAS): Assesses the sensitivity of incentive and aversive motivational systems. It includes 24 items rated on a four-point scale rating from 'Very true for me', to 'Very false for me'. The items pertaining to the BAS comprises of three separate sub-scales identifying levels of rewards responsiveness, drive and fun seeking. The BIS scale items identify sensitivity to anxiety. (Carver & White, 1994)

Analysis

All statistical analyses were conducted using the Statistical Package for the Social Sciences, version 24.0 (SPSS 24.0). A two-way mixed ANOVA was performed to test for mood induction and order effects. Pearson product-moment correlation coefficients were generated to assess the degree of association among the predictor variables. Based upon these results, a series of hierarchical regressions were conducted to examine the extent to which relevant factors were associated with reactivity to a sad mood. All predictors were mean centred.

Results

A two-way mixed ANOVA was performed to explore the efficacy of the mood induction procedure and test for possible order effects. The within-subjects factor consisted of the VAS ratings of sadness at baseline and following the MIP conditions (Neutral and Sad) and the between subjects factor was controlled for order (Sad/Neutral, Neutral/Sad). Mauchleys' Test of Sphericity indicated the assumption of sphericity had been violated, therefore the Greenhouse-Geisser was used. As displayed in Figure 2, there was a significant main effect on ratings of sadness ($F(1.48,140) = 75.49$, $p < .001$, $\eta_2 = .35$) and no differences were seen as a function of order, $F(1.48,140) = 1.36$, $p = .25\ 1$, $\eta_2 = .01$.

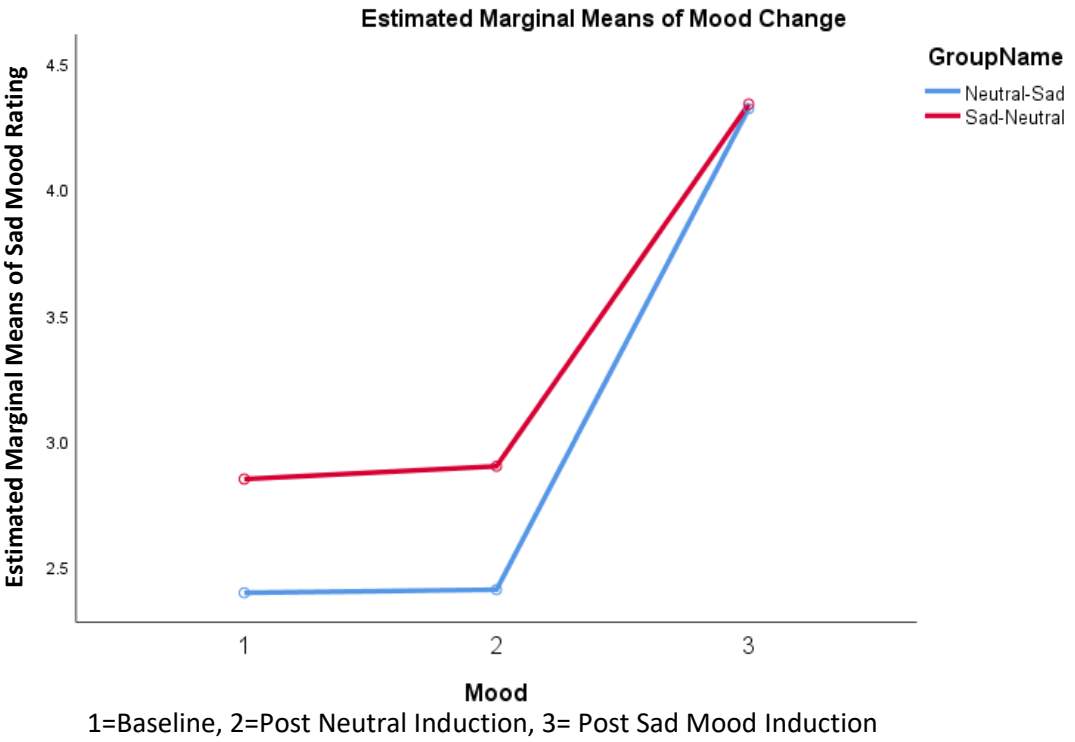

Figure 2. *Mean mood ratings before and after the Mood Induction Paradigm comparing group AB and BA*

A review of scores revealed that eleven participants reported a decrease in level of sadness from baseline to post sad mood induction. These were noted as outliers and excluded from

further analysis. The following analyses were performed with the remaining 129 participants (69.8% Female, Mean age= 19.41).

As can be seen in Table 1, Pearson product-moment correlation examining the association between baseline sadness (SAD1) and baseline measures of cognitive and emotional functioning revealed small to moderate associations with measures of anxiety (GAD), hostility, executive functioning (EF), self-regulation of emotion (Self-Emo), the behavioural inhibition system (BIS) and sad mood after the sad mood induction (SAD2). No other baseline measures were significantly associated with baseline sadness.

Table 1. *Significant Pearson correlations for sadness at baseline*

	GAD	Self-Emo	Hostility	BIS	EF	SAD2
SAD1	.18	.32	.23	.21	.19	.42

A Pearson product-moment correlation was also performed to analyse the association between sad mood after the sad mood induction (SAD2). As seen in Table 2, small to moderate associations were found between SAD2 and EF, Self-regulation of Emotion (Self-Emo), Anger, the Affective Reactivity Index (ARI), the Behavioural Inhibition System (BIS) and baseline sadness (SAD1). All other demographic, cognitive, and affective factors were not significantly associated with subjective ratings of sadness following the sad mood induction.

Table 2. *Significant Pearson correlations for sadness after the sad mood induction*

	Anger	Self-Emo	ARI	BIS	EF	SAD1
SAD2	.25	.25	.27	.43	.20	.42

In order to analyse the factors associated with emotional reactivity, that is the change in sadness score from baseline through to sadness after the sad mood induction, a pairwise correlational analysis was conducted where associations with SAD2 were examined while controlling for baseline sadness. Table 3 shows that Verbal Aggression (VA), Anger, ARI, Self-Restraint, the Behavioural Activation System- rewards responsiveness component (BASRR) and BIS were all factors that were found to be significant in this analysis. No other factors were significant.

Table 3. *Significant Pearson correlations for sadness after MIP controlling for baseline sadness*

	VA	Anger	Self-Restraint	BAS_RR	BIS	ARI
SAD2	.21	.24	.18	.20	.40	.24

A six stage hierarchical multiple regression was performed to determine the predictive value of the factors from Table 3, on sad mood after the MIP. Factors were loaded in order of the level of partial correlation. Baseline sadness was loaded in the first block of the regression analysis. As anger and irritability are similar constructs and correlation analysis resulted associations being of the same strength, the factor of Anger was not included in this analysis.

The results from the regression showed that the BIS accounted for 12.3% of the variance ($F(1,129)=22.15$, $p<.001$), significantly predicting sad mood following MI over and above baseline sadness. The addition of other correlates did not significantly increase the predictive value of this model (see Table 4).

Table 4. *Summary of Stepwise Regression Analysis for Variables predicting Sadness after Mood Induction*

Variable	β	*t*	*R*	R_2	Δ R_2
Step 1			.42	.18	.18
SAD1	.69	5.24*			
Step 2			.55	.30	.12
SAD1	.56	4.53*			
BIS	.19	4.71*			
Step 3			.56	.32	.01
SAD1	.55	4.48*			
BIS	.17	4.03*			
ARI	.16	1.68			
Step 4			.57	.32	.00
SAD1	.56	4.55*			
BIS	.17	3.98*			
ARI	.11	1.03			
VA	.06	.98			
Step 5			.57	.32	.00
SAD1	.57	4.5*			
BIS	.17	3.59*			
ARI	.11	1.03			
VA	.06	.96			
BAS_RR	.01	.09			
Step 6			.58	.33	.01
SAD1	.58	4.6*			
BIS	.17	3.66*			
ARI	.08	.74			
VA	.02	.31			
BAS_RR	.03	.34			
Self_Res	.16	1.46			

Note. *=p<.001

Post hoc analyses were conducted to explore current issues related to the factors that make up the BIS. Based upon Heym (2008), the BIS was split into two factors; BIS Anxiety (BIS_Anxt, 4 items) and the Flight, Fight or Freeze System (FFFS, 3 items). Pearson correlation analysis revealed that both of these factors were significantly correlated with report of baseline sadness and sadness after the sad mood induction (see Table 5). A pairwise correlation analysis showed that both BIS_Anxt and FFFS were significantly correlated with sadness after the sad mood induction, when controlling for baseline sadness (see Table 6).

Table 5. *Pearson correlations with baseline sadness and sadness after the MIP*

	BIS_Anxt	FFFS
SAD1	.17	.21
SAD2	.43	.32

Table 6. *Partial correlations with Sadness after the MIP controlling for baseline sadness*

	BIS_Anxt	FFFS
SAD2	.39	.26

A three step hierarchical multiple regression was conducted to determine the predictive value of the anxiety and fear constructs of the BIS on emotional reactivity. Sadness post mood induction was used as the dependent and baseline sadness was loaded in the first block. The two factors were loaded in order of the level of partial correlation from Table 6.

Table 7. *Summary of Stepwise Regression Analysis for Variables of the BIS predicting Sadness after Mood Induction*

Variable	β	*t*	*R*	R_2	Δ R_2
Step 1			.42	.18	.18
SAD1	.69	5.24*			
Step 2			.55	.30	.13
SAD1	.59	4.76*			
BIS_Anxt	.19	4.8*			
Step 3			.56	.31	.00
SAD1	.57	4.59*			
BIS_Anxt	.27	3.64*			
FFFS	.08	.79			

Note. *=$p<.001$

The hierarchical multiple regression showed that BIS_Anxt contributed significantly to the regression model ($F(1,129)=23.07$, $p<.001$). It accounted for 12.7% of the variance in sadness after the sad mood induction. The addition of FFFS did not add any significant predictive value (see Table 7).

Discussion

The purpose of this study was to investigate factors associated with emotional reactivity in the context of a laboratory based sad mood induction. Based on past research, it was expected that measures of inattention, irritability/aggression, depression/anxiety, executive functioning and personality, including the behavioural inhibition system, would be associated with level of emotional reactivity.

In order to explore these associations, data was collected from a nonclinical sample of individuals participating in a laboratory based sad mood induction paradigm. As part of this study, a selection of self-report measures were collected from participants, including information describing both past and current cognitive and affective patterns.

Results demonstrated that the mood induction was successful in eliciting a sad mood response. Initial analysis showed that, in line with expectations, factors of anger, self-restraint, irritability, rewards responsiveness and behavioural inhibition system were significantly associated with higher levels of emotional reactivity. However, further analysis revealed that, when controlling for other factors, the BIS was the only significant factor in predicting emotional reactivity. This association is consistent with other findings as the BIS is regarded as a measure of responsivity to negative events or stimuli (Thake & Zelenski, 2013). Stemming from Gray's (1970) Reinforcement Sensitivity theory, the BIS is known to be linked to neuroticism, a trait which is thought to be associated with emotional reactivity (Steenhaut et al., 2018). The BIS is related to inhibiting behaviours that are associated with negative outcomes and with feelings such as fear and anxiety (Carver & White, 1994). The results from this study suggest that sadness can also be added to this list. To our knowledge, this is the first study to demonstrate the relationship between the BIS and sad mood reactivity in a laboratory based mood induction.

The lack of predictive value, after accounting for BIS ratings, of any of the other measurements is surprising. In particular, as measures of depression, anxiety, affective reactivity, self-restraint and emotion regulation have been previously shown to strongly relate to emotional reactivity (e.g. Beccera & Campitelli, 2013). The correlational analyses from this study does support these findings however, these associations were nonsignificant when examined in conjunction with the BIS. The BIS has been linked in previous research to psychopathologies including anxiety, depression and ADHD which could be the reason for its overriding predictive value. Additionally, this study, which recruited a sample of university students, filtered for any participants who scored too highly on either the depression or anxiety scale. It could be expected that the association of depression or anxiety with emotional reactivity may not be as strong as it would be in a clinical sample as the depression and anxiety themselves are not as pronounced.

Revision of the BIS Construct

Gray's original 1972 theory of personality, from which the BIS/BAS scale was created, has been revised to include a third construct, the Flight, Fight, Freeze construct (Gray & McNaughton, 2000). At this point, the literature is unclear as to whether or not this model adds value to the measurement of emotional reactivity. This model of reinforcement sensitivity theory consists of three systems; the Behavioural Activation System, the Behavioural Inhibition System and the Flight, Fight, Freeze system. The BAS remains unchanged and stands as the reward system which regulates appetitive motivation (Gray, 1982). Recent studies have posited that, although it has always been thought of as a singular scale, the BIS scale may in fact, be representative of two separate sub-scales: fear and anxiety (Gray et al., 2016). The BIS was previously described as the system to regulate all behaviour motivated by an aversive event while, with the addition of the FFFS, aversive events have

been split into two groups (Maack & Ebesutani, 2018). The BIS is now thought to act as a conflict and resolution system responding to anxiety, whereas the FFFS is suggested as responding to fear, reacting with escape or avoidance (Maack & Ebesutani, 2018). This study showed that the anxiety domain of the BIS significantly predicted emotional reactivity on its own. The fear domain however, did not significantly predict emotional reactivity after accounting for the BIS anxiety ratings. This supports the theory that the BIS construct should be split into two separate domains.

The theory of the BIS being redefined by fear and anxiety is interesting in this context as it does not explicitly include sadness, yet the results of this study show that sadness is associated with the BIS. One possible explanation for this could be that the mood induction is inducing anxiety rather than sadness or that the feeling of sadness, in this situation, results in an anxiety based response to be resolved. For example, the sentence: *'I am not good enough'*, may invoke a state of sadness in some individuals, whereas with others they may feel fear about not living up to society's standards, or anxiety that they will never get there. While participants reported higher levels of sadness after the mood induction paradigm, it could be possible that they were simply measuring feeling 'worse' than before, and with the priming of this being a sad mood paradigm, they may have assumed this negative feeling was sadness rather than anxiety. It would be useful for future studies to include a measure of anxiety pre and post mood induction in order to separate the two emotional reactions.

Limitations

Mood Induction Paradigm

An important note to consider with this study is that, while the results do show that the mood induction was successful in inducing a sad mood, there are limitations to the effects of an artificially induced mood. The effects of the mood induction were moderate therefore

meaning that the associations found in the study were perhaps less significant than would be found in a real life example. Westermann et al. (1996) also note that mood inductions can elicit multiple moods rather than the pure, specified mood which could explain the high correlation with the anxiety construct of the BIS as both sadness and anxiety may be being induced as a part of the procedure. The results of this study showed that overall the mood induction was successful in increasing levels of sadness, however, that is only taking into account the average and not the individual change scores. A closer look at the change scores revealed that eleven out of the 140 participants (7.86%) actually scored lower in sadness after the sad mood induction, signifying that the mood induction did not perform in the expected way for close to eight percent of the sample. It is currently unknown as to why these participants would have reacted this way and could be an interesting focus for future research.

Effect Size

The effect of the mood induction on reported level of sadness was mild which could limit the strength of the results found in this study. An alternative view on this however, could be to see this as a strength of the results. Considering the findings of a significant predictor based on such a mild effect size, it would be reasonable to expect, if analysing a data set with a larger effect size (perhaps due to being a clinical sample), that the predictive value of the BIS may increase in significance.

Sample Population

It is necessary to acknowledge that the sample used for the current study was a non-clinical sample with a restricted range of depression and anxiety levels. This may have had a subduing effect on the results found as, in general, a non-clinical population is less likely to

exhibit emotional reactivity that is outside of a typical range. The same limitation applies for the factors associated with emotional reactivity, resulting in potential predictors appearing less significant.

Measurement of Emotional Reactivity

One of the major limitations in this study is that the measurement of emotional reactivity does not provide a complete understanding of the participants' emotional reactivity. Research suggests that emotional reactivity can be defined by three separate stages and therefore that individuals can differ in one or more dimension of reactivity (Davidson, 2015). These stages include, activation, intensity and duration. Activation can differ in the threshold of event needed to stimulate a reaction; intensity, refers to the amplitude of the arousal at its peak; and duration is the length of time it takes for an individual's emotions to return to baseline. This study measures reactivity as the change in level of sadness at baseline to the level of sadness after the mood induction, effectively measuring the level of arousal. A further measure is taken before the participants were able to leave the study therefore capturing duration. Activation, however, is not specifically measured. While historically research has assumed that there is coherence across the dimensions of emotion reaction (Ekman, 1992), evidence is inconsistent and somewhat lacking in empirical support for this theory (Evers et al., 2014). Although there is still much that is unknown about their relationship, it is likely that the three dimensions of emotional reaction often only modestly correlate with one another and that this may be dependent on type of reaction or emotion (Evers et al., 2014). There is some support for this theory, that an individual's response may match another's in one dimension (e.g. activation) yet differ from that same individual in another dimension (e.g. duration). For this reason it would be informative if future research were to include a measure of activation.

Future Directions

In line with personality theories, it would be interesting to include measures of extroversion and neuroticism in order to identify if the BIS would maintain its predictive value in the presence of these traits. Carver & White's BIS/BAS scale that was used in this study is based on Gray's (1970) Reinforcement Sensitivity Theory which states that individuals who display higher levels of neuroticism, are more sensitive to punishment and therefore more reactive to negative events or triggers. Whereas, those higher in extraversion are more sensitive to reward and therefore more reactive to positive events or triggers. Neuroticism and the BIS have been strongly linked in the literature (Carver &White, 1994) therefore it would be worthwhile collecting a specific measure of neuroticism in order to establish if the BIS is predictive of emotional reactivity regardless of level of neuroticism.

Clinical Population

The results from this study provide enough evidence of significant associations that a study using a clinical sample is justified. As emotional reactivity and emotion dysregulation is known to be connected to a number of negative outcomes (e.g. Barkley, 1997), the study of sad mood reactivity within a clinical population could be informative in establishing associated factors. This could help to identify disordered behaviour or thinking before it has progressed to a clinical level.

Measurement of Emotional Reactivity

In order to get a more accurate reading of the level of emotional reactivity it could be useful to take physiological measurements of participants throughout the experiment to gauge at which point the reaction occurred, peaked and returned to baseline. It is important to note

however, that levels of physical reactivity and levels of subjective reactivity to a stimulus are not always consistent with one another (Steenhaut et al., 2018).

Conclusions

The current study has provided evidence of an association between the BIS and level of emotional reactivity in the presence of a sad mood induction. To the best of our knowledge, this is the first such study to be focussing specifically on predictors of emotional reactivity to a sad mood induction. The results support theories put forward in the literature about associations of emotional reactivity with measures of behavioural inhibition, depression, anxiety, affective reactivity, self-restraint and emotion regulation, although perhaps not to the strength that would be expected. Results can be used to inform future research in the field by creating a platform for work with a clinical population.

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